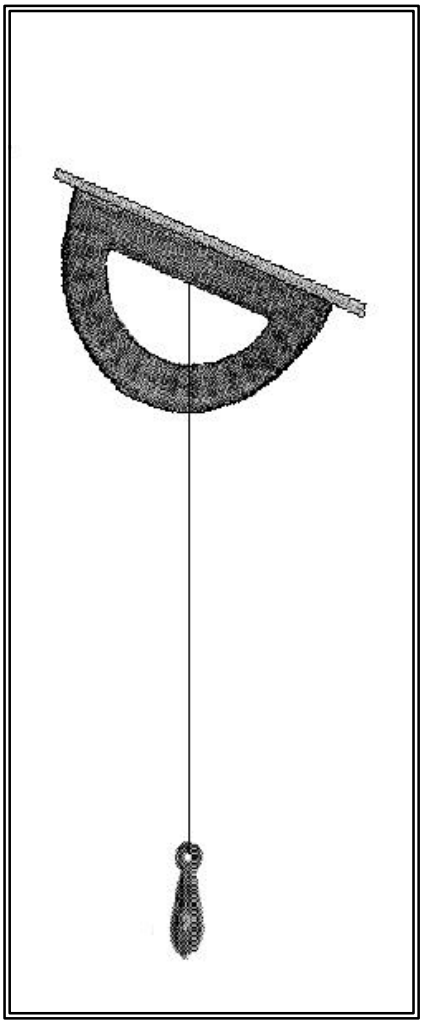
Water Distribution 1

📖 Duration:
Pre-visit: 2 hours
Visit: 15 minutes
Post-visit: 2 class periods

📖 Setting:
Classroom, outdoor area on campus, Mission Espada *acequia*, Mission San Juan dry *acequia*

📖 Skills: Grades 6-8
Math: 6.11 Applies mathematics to solve problems connected to everyday experiences, investigations in other disciplines and activities in and outside of school.
7.9 Solves application problems involving estimation and measurement.
8.1B Selects and uses appropriate forms of rational numbers to solve real-life problems including those involving proportional relationships.
Science: 6,7,8.1B Conducts field and laboratory investigations using safe, environmentally appropriate



Materials:

Engagement (Pre-visit): Texas map showing missions and rivers (found on San Antonio Mission brochure)

Elaboration (Pre-visit):
- annual rain fall map
- video tape "Gente de Razón"
- Southton Quadrangle 7.5 minute Series (USGS Topographic Map) showing the San Antonio River
- string
- ruler

Field Explorations (Pre-visit) Equipment for establishing contour lines.
- Clinometer made from a protractor and a mass hanging from a string and a drinking straw for sighting. (See drawing).
- Two meter sticks
- Contour markers (stakes made from coat hangers with colored flags attached)
- Established bench mark for schoolyard
- Compass
- Colored tape

Optional Elaboration (Pre-visit) Equipment for modeling contour intervals
- Spaghetti
- Photocopies of Southton Quadrangle 7.5 minute Series (USGS) (If area is large, reduction may be necessary.)
- Glue

Elaboration (Visit):
- photocopy of part of Southton Quadrangle 7.5 minute Series (USGS) showing the river where the Missions are located
- equipment for establishing contour lines

Engagement (Pre-visit):

1. Brainstorming session: Take 2 minutes to write down what you know about the San Antonio Missions? Who lived there? What was their daily life like? What were their basic needs in their daily life? Share your ideas with the class.

2. Locate the missions on the Texas map in the mission's brochure. What is the relationship between the missions and the river?

3. View introductory video, "Gente de Razón" [23 minutes.]

4. Class discussion and brainstorming session:
a. Compare answers with #1 above.
b. Were you surprised about anything in the video?
c. What did the video show about water and its distribution at the missions?

5. Use the map of average rainfall to determine San Antonio's average rainfall?

Exploration (Pre-visit):

Use multimedia resources (books, films, CD's,etc.) to solve the following problem:

1. You are an early missionary at Mission Espada. The crops depend on rain, which in this semiarid region is not frequent enough to grow enough food for all the people who will live at the mission. Your job is to plan how to get water to irrigate the fields. Consider each of the following questions:
a. What information would you need?
b. Where would you go to find the information?
c. What equipment would you need?

2. Write down your ideas and then share them with your group. Have a recorder in each group report to the entire class the group's questions and ideas.

Explanation (Pre-visit):

Compare your group's ideas to the system used in the San Antonio missions.

Used here was the Spanish *acequia* system used in Spanish colonies as well as in Spain. Read about the *acequia s*ystem in the San Antonio Missions brochure.

The *acequias* followed the natural slope of the land, basically crossing what we call a contour line. All parts of a contour on the ground are at the same elevation above sea level. In order for water to flow, the *acequia* builders had to gradually make the *acequia drop* to a lower elevation. They used the force of gravity to move the water.

Historians believe the missionaries checked the slope for an *acequia* by pouring water into a ditch to see which way it flowed.

Elaboration (Pre-visit):

What information can a topographic map of the mission area tell us about the *acequias*?

1. On the Southton Quadrangle, 7.5 minute Series (USGS Topographic Map.) look in the northwest corner of the map between longitudes W 98 30' and W 98 27'30" to find the San Antonio River.

2. Follow the San Antonio River past Mission San José until you see Mission Espada Dam. Look immediately upstream from the dam to find Mission Espada's *acequia*.

3. Follow the Espada *acequia* to Six Mile (Piedras) Creek. An aqueduct was built for the *acequia* to cross this creek. We will visit this aqueduct which is the oldest Spanish colonial aqueduct still in use in the United States.

4. Directly across the San Antonio River from the *aqueduct* is Mission San Juan Capistrano. We will stop at the San Juan *labores* (farm fields).

5. Look farther down the San Antonio River for the following: Mission Espada and its *labores*, the location where the San Juan a*cequia* returns to the San Antonio River, and the location where the Espada *acequia* enters the San Antonio River.

How long was the *acequia* that the Christian Indians dug for Mission Espada?

1. Using a piece of string, measure the distance the *acequia* covers from where it starts above the Espada Dam to where it empties into the San Antonio River.

2. Use the scale at the bottom of the map to change the string's length to true distance. Record this distance. This is the length of the irrigation ditch the Spanish missionaries and the mission Indians dug beginning in 1731.

What is the slope of the land that the *acequia* follows?

1. Find the slope of the land at one place along the *acequia* on the topographic map. Measure with a string the distance between two consecutive contour lines that cross the *acequia*.

2. Use the scale at the bottom of the map to change your string's length into true distance.

3. Divide the contour interval by the true distance. Record your slope and compare your answers with other students.

Field Explorations (Pre-visit):

How can we measure and mark contour lines on land areas of interest? A contour line represents points that are at the same elevation (distance above sea level).

Pre-lab: Each team is assigned a part of the schoolyard where two contour lines can be established. Before establishing contour lines, each group should look at the area in the schoolyard and predict where contour lines will exist. Make a preliminary sketch.

1. Begin at the benchmark your teacher indicates. [Teacher note: Mark an estimated benchmark if you can not find one on building plans of the school.]

2. A student holds the meter stick vertically. (The plumb bob string of the clinometer should lie along the side of the meter stick over its entire length. The string of the plumb bob should cross 0º on the protractor so the straw will be level.

3. Place the clinometer at 1.0 m above the ground on the pole and keep it level. A second student sights through the straw looking for the red tape at 1.0 m above the ground on the second meter stick. The third student must move the second meter stick until the second student has sighted the red tape through the straw. A red colored flag is placed in the ground at this point.

4. Repeat the third step until two more flags have been placed several meters from each other. (For this step, do not move the meter stick. Only rotate the straw horizontally to sight the red tape at 1.0 m on the second pole at a new location.) The base contour line has been established where the red flags are placed at the s ame elevation.

5.Use familiar objects (buildings and trees) and your compass to place the three red flags (contour line) on a map.

6. To sight another contour line 0.5 m higher in elevation, repeat steps 3 and 4. This time the tape on the second stick should be placed at the 0.5 m point. Blue tape and a blue flag will help to indicate that this is another contour line at a different elevation.

7. In a manner similar to step 5, place the new contour line on your map.

8. Place a scale on your map to indicate the contour interval.

Teachers: On some campuses 0.5 m interval may not be appropriate. If the campus is very level, a different location may be used for the field exploration. If the campus is very steep, several other contours will be needed. A third contour line can be established by looking for green tape at 0.0 m on the meter stick and placing a green flag at that point. If more contour lines are needed, the first meter stick can be moved to contour line three and the process for establishing the first three contour lines can be repeated.

9. Measure the linear distance from the first contour line to the contour line 0.5 m higher. Record it on your data table.

To answer the following questions, use the contour maps of the campus prepared by the entire class.

1. Look for a place where the two contour lines are closer together (the linear distance between lines is short). What is the slope of the land at that place? Make a sketch to indicate the slope of the land.

2. Look for a place where the two contour lines are farther apart (the linear distance between lines is long). How does the slope of the land here compare with the one where the contour lines are closer together? Make a sketch to indicate the slope of the land.

What is the slope of the land?

Slope can be measured in another way by holding the protractor's flat edge parallel to the surface of the land. Measure the angle between 0º on the protractor and the plumb bob string.
Record the angle of the slope.

1. What is the slope you measured? (Be sure to include units.)

2. Do you think your measurement for slope will be the same as that of the other groups? Give a reason for your answer.

3. Compare class data. Which group had the steepest slope? Compare the spacing of the contours for the steepest slope to the spacing for other slopes.
Which group had the gentlest slope? Compare the spacing of the contours for the gentlest slope to the spacing for the other slopes.

4. What can you conclude about how contour lines represent the slope of the land?

5. What force would cause water to run down the slope from one contour to the next? Explain your answer.

6. How can the force you mentioned above be increased? Decreased?

Optional Elaboration (Pre-visit):

An alternate way of finding the slope of the land (from a commercial map or a map you make yourself).

1. Record the linear distance between two contour lines and the contour interval (the difference in height between two contour lines).

2. Divide the contour interval by the distance between the two contour lines. The contour interval in the investigation was 0.5 m. Be sure to use the units.

3. Use graph paper to make a scale model of the slope. The measurement of the slope can be found by marking the contour interval on graph paper on the vertical axis. Mark the measured horizontal distance between the two contours on the horizontal axis. Draw a line from the point on the vertical axis of the graph paper representing the height of the contour interval to the point on the horizontal axis representing the distance between the two contour intervals. Use a protractor to measure the angle formed between the line drawn and the horizontal axis.

How do you make a model of a topographic map?

Teacher: Make one photocopy on tag board (manila folder) of the topographic map for each contour interval in the area to be shown in the model. This produces a set for one group of students.

1. The base level of the map is the river level.

2. One map serves as a foundation and is kept intact. Glue one layer of spaghetti over all of the areas except the base level.

3. The next map is left intact except for cutting away the base level. Glue this map over the spaghetti on the foundation map. On this map glue spaghetti on all areas except the base level and the next level above the base level

4. On the next map cut away the base level and one level above it. Glue this map over the spaghetti.

5. Continue the process of removing the next higher level at each step; glue this on and add spaghetti until only the field area is covered with spaghetti in the last step.

Elaboration (Visit):

Gather data to answer the following questions at the missions indicated. DO NOT CROSS THE CREEK OR CLIMB ON THE AQUEDUCT.

What is the slope of the Mission Espada *acequia at* the aqueduct?

1. Measure the slope of the *acequia* at the aqueduct. Use the protractor to measure the slope. Use the same procedure that was used in the Field Explorations (Pre-Visit) Record the slope.

2. With the same procedure used on the school campus with the meter sticks and sighting clinometer, find the number of 0.5 m contour lines from the edge of the creek to the bottom of the aqueduct. Be sure to choose an area where the person who places the marker can stand easily. You will need to mark at least one point for each contour line. Using the number of contour lines, determine the height of *acequia* above the creek. Sketch the points of the contour line on the Espada *Acequia* Piedras Creek Aqueduct Site Plan.

What is the slope in the bottom of the dry *acequia* near San Juan? Use the sighting clinometer to collect data. Record the slope.

Visit Espada Dam where the Espada *acequia* begins (a good spot for lunch).

Evaluation (Post-Visit):

1. Compare the measurement in degrees for the slope of the aqueduct and for the slope of the *acequia* on the Southton, Tex. USGS topographic map. Compare the measurement of elevation in feet for the contour line closest to the aqueduct and for the contour line closest to the Mission Espada Dam on the Southton map.

2. Prepare a written report using the data and the conclusions from investigations at the school and at the missions. The teacher uses the general rubric to assess the reports (Alter as needed).

3. Present an oral report to the class summarizing the data and conclusions from the investigations at the school and at the missions. The class will use an oral report rubric to evaluate their peers.

4. Record data in the San Antonio Missions Historical Park's data bank.